

CYCLING

The first “two-wheeler” is a big event in a child’s life and often signifies a new degree of independence and wider boundaries of exploration. Many adults will remember the occasion and the bike fondly. They will be able to recall its color and make and describe their adventures learning to balance themselves and ride. It is true that once you learn how to ride a bike you will never forget, although you may become a bit “rusty.”

Bike riding or stationary bike exercise is often one of the most readily adaptable methods of aerobic conditioning. Stationary bicycles can be adapted to most individual physical capabilities and bikers can ride with or without a prosthesis. Bikers can ride outdoors, use a stationary bike indoors, or combine both modes in their conditioning program. Minor adjustments and/or adaptations to the prosthesis and bicycle are often needed; they are best determined individually through practice and experience.

Most people with lower limb amputation can receive much pleasure and physical benefit from cycling, with little risk of injury. Cycling places very little stress on the residual limb. It is essentially a non-weightbearing activity because the rider is seated most of the time. At the same time, it is one of the best ways to strengthen the quadriceps and hamstring muscles of the thigh as well as muscles of the hips. Besides training the cardiovascular system and building muscular endurance, cycling is an excellent method for strengthening the residual limb.

Individuals with BK amputations may find it to

their advantage to use their prosthesis while biking. Some people with an AK amputation and most with hip disarticulation may choose to ride without a prosthesis. For the rider with AK amputation, pedaling can cause socket impingement when flexing the hip. This can be remedied by the prosthetist in many cases. Those with hip disarticulation experience difficulty riding with a prosthesis, because the limb cannot be effective for pedaling without muscular control of the natural hip and knee joints.

TRAINING

A person with lower limb loss can train in much the same fashion as a nondisabled person. When beginning a program, it is best to slowly build up tolerance and endurance for long rides, increasing distance gradually. The gradual approach will also help prevent blisters on the residual limb which could limit walking and other activities. If blisters or other painful irritations occur after even a short distance, repairs or adjustments to the socket should be made by the prosthetist immediately.

Working out socket problems by training first on a stationary bicycle is a good preventative measure before taking long outdoor rides. On a stationary bike, one can stop immediately if blisters or irritation to the residual limb develop. Whereas, on a bike path, the rider may be a distance from home and find it difficult to return without causing further injury.

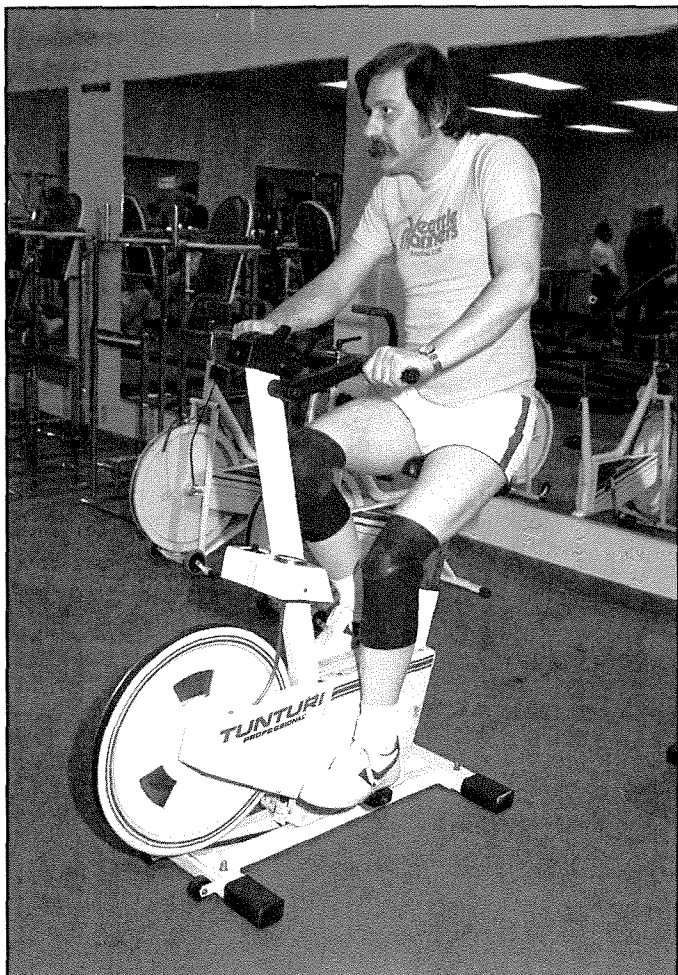
Stationary bikes offer a quick and convenient workout. They are available at health clubs and gyms. A wide range of stationary bikes may be

purchased for use in the home, ranging from relatively low-cost models to expensive, high-technology computerized bikes.



DAVE NELSON, BUENA PARK, CA

Vietnam veteran Jim Penseyers, who participates in the "McDonald's Race Across America," prepares for a race with the assistance of his brother, Pete. He wears toe clips and a strap to keep his prosthetic foot positioned on the pedal.



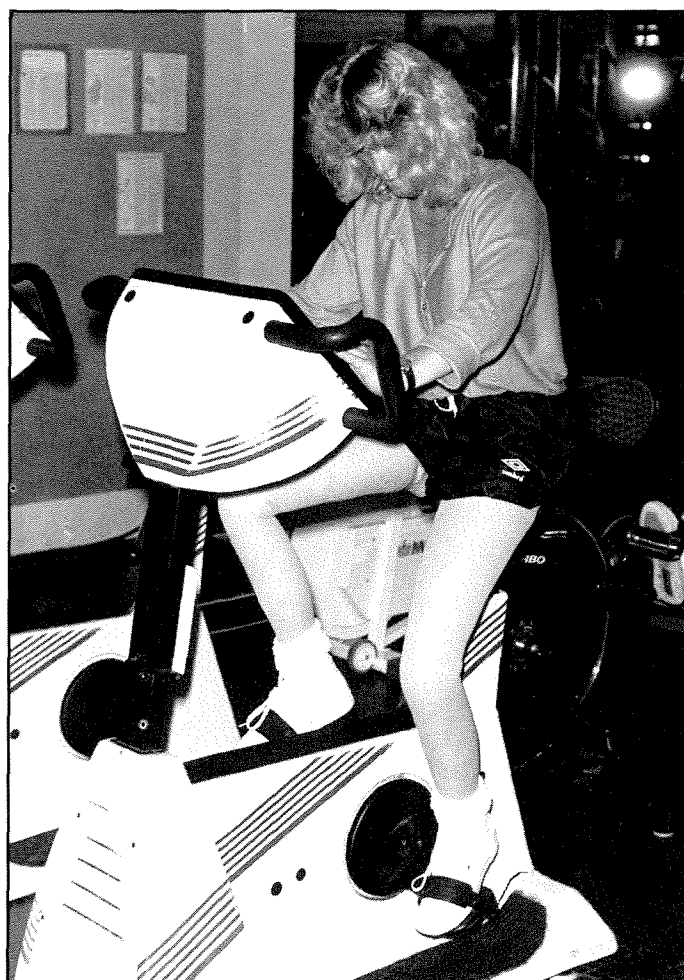
JOHN WOODMANSEE/VAMC, SEATTLE, WA
John Everett builds cardiovascular fitness as well as strength in his BK residual limbs by working out on a stationary bicycle. Note that the middle of his feet are positioned on the pedals. This provides for a more effective push and keeps his feet from slipping off the pedals (since no toe clips are available on this model).

PEDALING

Pedaling a bicycle requires both hip and knee flexion through a wide range of motion. The rider with a BK amputation may experience socket problems relating to lack of knee flexion, while AK amputees may have socket brim problems primarily related to lack of hip flexion. These prosthetic problems are most commonly addressed by using flexible sockets or lowering socket trim lines. Raising the bicycle seat will also improve socket impingement because the amount of knee and hip flexion is decreased. Flexion problems can usually be solved

with these adjustments and with the assistance of the prosthetist. Adjustments are often made by trial and error while the rider exercises on a stationary bicycle. The prosthetist can often solve a problem best if he/she is able to observe while the rider is pedaling.

There may be problems in keeping prosthetic feet on the pedals. Toe clips, or custom-designed straps attached to the pedal, can keep the foot in place. A strap may be added to the pedal to secure the heel or midfoot if desired. However, toe clips on bilateral prostheses can hinder the ability to get off the bicycle quickly and it may be safer to secure only one foot. Quick-release bindings that attach the bike shoe directly to the pedal or crank arm are available.

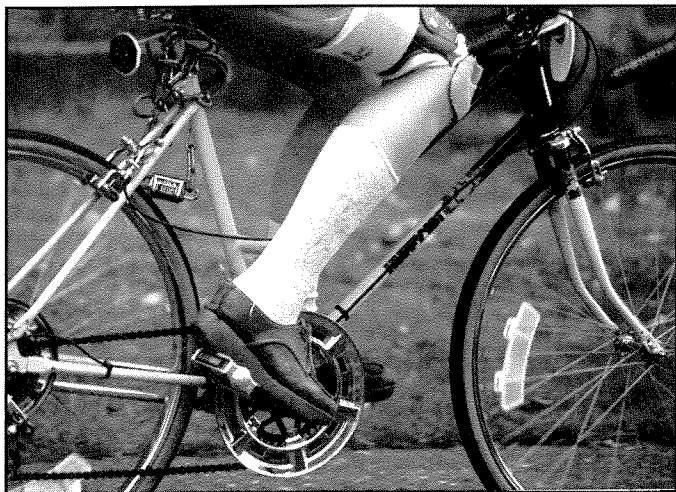


DALE TILLY/VAMC, SEATTLE, WA
Samantha Ellis tries a stationary bicycle for the first time with her Endolite prostheses. Her feet are securely attached to the pedals and the socket trim lines are designed so they do not impair her range of motion.

To gain power in pedaling, some people prefer to have the heel of the prosthesis or the peg leg positioned in the middle of the pedal since it has a more direct line of downward force underneath the socket. This adds a more effective transfer of energy to the pedal and provides increased proprioception to the rider. This method is also preferable because many prosthetic feet are very flexible in the toe areas and do not allow for an effective push on the pedal. Wearing flexible shoes such as sneakers makes pushing on the pedal particularly difficult. Those who pedal with the heel or midfoot while wearing tennis shoes or other non-biking shoes can attach a Velcro or leather strap to the pedal to prevent the prosthetic foot from slipping. Riders who use the ball of the foot for pedaling often just use toe clips.

Many riders find that a stiff-soled bicycling shoe works well when pedaling with the ball of the prosthetic foot on the pedal. If the rider does not use bicycling shoes, a stiff-soled shoe is preferable to a tennis shoe, and compensates for the flexibility that is built into most prosthetic feet. Certain feet, like the Flex-Foot, Springlite, Carbon Copy II, and DAS Foot have keels which extend to the end of the toe section. This feature makes these feet more effective than prosthetic feet with flexible soft toe sections.

Cycling power comes not only from pushing down on the pedals but also from pulling the pedal up. This is especially important when climbing long



PROSTHETICS RESEARCH STUDY, SEATTLE, WA

A biker wearing a BK prosthesis and stiff-soled shoes demonstrates the mid-foot position on the pedal which gives an effective push and helps keep the foot from slipping off the pedal.



GEORGE DEPONTIS, MIAMI, FL

Greg Mannino on one of his weekly rides to help stay in condition for the ski season. Greg uses an Endolite Foot, toe clips, and bicycle shoes. The Endolite ankle is multi-axial and provides for an improved range of motion.

hills. Hill climbing can be particularly difficult for the biker with a prosthetic leg. Even after gaining speed and momentum, the rider must often stand on the pedals in order to work them hard enough to ascend a steep or long hill. The upward stroke in pedaling constitutes a power loss, particularly on the side with the prosthesis. However, many bikers can improve upward pulling power on the prosthetic side with good socket suspension and by wearing toe clips and bicycle cleats. The newest technique available for suspension is the 3-S Silicone Suction Socket. The 3S suspension method for BK prostheses is helpful in the upward pull on the prosthetic side.

The equipment changes described above enable the prosthesis to work for the rider. If such adaptations are not made, the rider may find that the sound leg does all the work and the prosthetic leg is just "along for the ride."

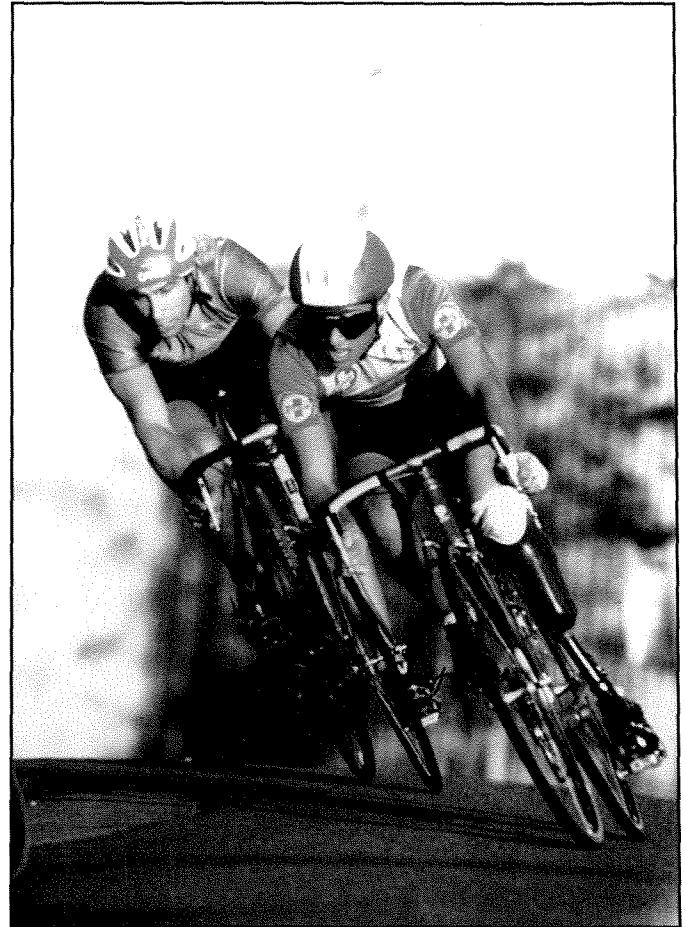
BELOW-KNEE ADAPTATIONS

A biker with BK amputation may experience limitation of knee flexion caused by the socket trim lines rubbing against the skin. Raising the seat on



GARRY STUBBS PRODUCTIONS/WEST COAST PHOTOGRAPHY,
OAKLAND, CA

Lance Younger is seen competing in the cycling portion of a triathlon. The peg leg attachment on the modified pedal uses a U-joint for direct connection to the pedal and increased range of motion in the ankle.



DALE BERRY, DAW INDUSTRIES, INC., SAN DIEGO, CA

Among the world's best cyclists is Charles Dempsey, who has a left BK amputation. He was a medalist in the 1988 Seoul Paralympics and is a member of the USAAA Olympic team. His graphite DAW prosthesis allows him to obtain speeds in excess of 50 mph while racing.

the bicycle or pedaling with the heel or midfoot can result in less need for knee flexion when going through the pedaling motion. The prosthetist may be able to lower the trim lines on the back wall of the socket to increase range of motion. However, he/she may hesitate to do this on a prosthesis for a residual limb because it can create anterior distal problems of the tibia when the prosthesis is used for walking. A diagonal trim line or lowered medial hamstring relief can be built into the prosthetic design when there is a clear intention of bicycle riding on the part of the user.

Sleeve suspension can also limit flexion of the knee to a certain degree. Some individuals use a neoprene sleeve against the skin and a latex sleeve

on top of it. The neoprene prevents irritation of the back of the knee and the latex outer sleeve adds additional suspension. Sleeves are hotter than other forms of suspension, and some individuals perspire more while wearing them (many do wear them successfully). Suprapatella cuff straps are the most common form of suspension and are used by many BK cyclists. The 3S socket requires no supracondylar suspension, sleeves, or straps, and is becoming increasingly popular. It also aids in providing extra power pulling up the prosthesis while the sound leg is pushing down.

Many cyclists with BK amputation have been successful in competition. Lance Younger, who has a unilateral BK amputation, competes in triathlon events on a regular basis and generally places within

the top five against nondisabled competitors. He races with a modified peg leg that attaches directly to the pedal, which then allows increased ankle mobility because of the U-joint which is incorporated into the design. This design also makes his leg part of the bike. Younger has tried a foot in the pedals, but finds it limiting for his particular needs. He prefers peg legs for walking as well. He also prefers a supracondylar/suprapatella socket suspension design, which he finds does not limit his knee flexion.

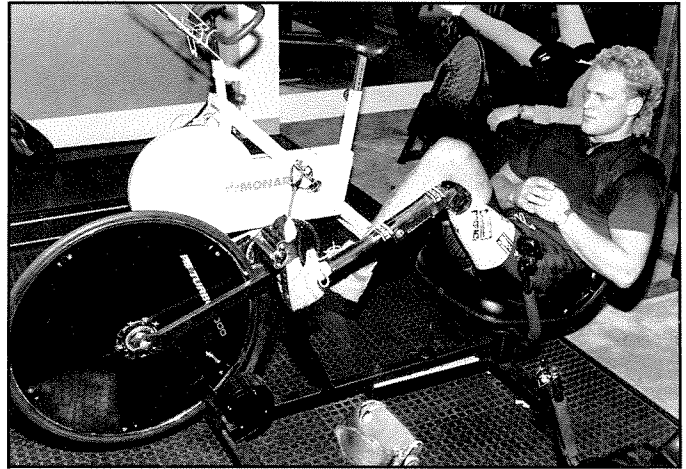
Charles Dempsey and Jim Penseyers compete in national and international events with nondisabled cyclists. Both use regular biking shoes, toe clips, and a suprapatella cuff strap. Jim Penseyers uses a double-thickness silicone liner for bicycling, a Seattle Foot for commuting to work (over 300 miles per week), and a Flex-Foot for racing.

ABOVE-KNEE OR KNEE DISARTICULATION ADAPTATIONS

The person with AK amputation or knee disarticulation has decreased strength due to impaired strength of the knee on the prosthetic side. Socket impingement when flexing the hip can be reduced by using a flexible brim socket. Using a Mauch SNS Knee Unit in the free-swinging mode removes resistance on the knee and provide for an easy follow-through while pedaling. (When bicycling is performed as a strengthening exercise, the knee control mechanism can be adjusted to produce a varied amount of resistance.)

When knee range of motion is greatly limited, there are two options for reducing the amount of knee flexion required for pedaling. One is to raise the seat level; the other is to put the heel, rather than the ball of the foot, on the pedal (it may be necessary to secure the heel with a strap to keep the foot in place on the pedal).

It is important to have a prosthetic socket that provides flexibility around the trim lines, either from a flexible brim or from a standard brim that has a low enough trim line to accommodate movements required for both bicycle riding and walking. CAT/CAM sockets or Narrow M/L sockets are preferred, and can be used effectively in combination with a regular walking prosthesis. A socket with suction fit and, if necessary, a Silesian belt or TES



DALE TILLY/VAMC SEATTLE, WA

Greg Mannino demonstrates conditioning on a stationary bike in a reclining position, which is an option for those whose balance or upper-body strength is poor. This position also provides extra back support and a relaxed angle for knee and hip flexion.

belt for additional rotary control and suspension capability, is also recommended. Riders should be aware that the foam cover on conventional AK endoskeletal units may tear from the friction caused by pedaling.

Greg Mannino, one of the top three-track snow skiers in the world, trains in the off-season by bicycling. He wears his prosthesis for conditioning, and pedals over 100 miles a week. When cycling, his prosthesis incorporates the Mauch SNS Knee Unit used in a free-swinging motion as well as the flexible brim CAT/CAM-designed socket. The flexibility of the brim affords him a wide range of unrestricted motion. He uses bicycle shoes and toe clips, which provide effective transfer of force to the pedals.

Bilateral Above-Knee Adaptations

Riding a standard bicycle requires skill, balance, and practice. Knee and hip flexion are required to pedal. Adequate knee and hip flexion for bicycling are difficult to achieve for the person with bilateral AK amputation. However, cardiovascular exercise can be performed using a stationary bicycle, an arm ergometer, or an adaptation of the row cycle, where the arms are used for pedaling either from a wheelchair or a special rowing cycle. Rowcycling (hand pedaling) attachments to wheelchairs also provide good upper-body aerobic condi-

tioning. (Such devices are available from New England Hand Cycles.)

Hip Disarticulation Adaptations

Most people with a hip disarticulation do not wear a prosthesis for bicycle riding. They usually remove the pedal on the side where there is no leg and pedal with only the sound leg. This method can work well as long as the sound leg is not overly stressed during the exercise. To further accommodate for this style of riding, the seat may be padded and turned toward the disarticulated side. This adaptation gives added pedaling strength to the sound leg, and compensates for the increased demands made to the seat design by one-legged pedaling. Cyclist Dave Kiefer, who has a hip disarticulation, has successfully competed in the "Ride Across America" several times.

SPECIAL CARE

Although bicycling is essentially a non-weightbearing activity, skin problems can occur from friction along the trim lines of the prosthesis,

as well as from heat build-up. For the person with a BK prosthesis, friction may be reduced by using a DAW, Hood, or Comfort Products sheath over the residual limb. The trim lines around the brim should either be flexible or low enough to allow a full range of motion while pedaling. This will help prevent irritation in the hamstrings or femoral condyle areas, particularly for PTS or supracondylar BK prosthesis users. Spenco™ 2nd Skin™ and Spenco™ Skin Care Pads, Johnson & Johnson Bioclusive® Pads, or DuoDerm by Squibb can be used as preventive maintenance or to aid in healing blisters.

Individuals with an AK amputation who have problems with hip flexion or socket impingement should consult their prosthetists for possible modifications to the trim lines. (Flexible brim sockets and lower trim lines will help.) Modifications also can be made to the posterior seat of a quadrilateral socket, reducing the risk of skin irritation from long periods of cycling.

Bikers should take care to keep the prosthetic sockets clean. It is helpful to wash the residual limb after biking and clean the socket daily so as to prevent skin problems caused by excessive perspiration. The Hood Socket Cleaning kit, available from a prosthetist or Camp International, may be used.